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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	13DV13511
First Inventor or Application Identifier	Shannon L. Korson
Title	Method and System for Exporting Flight etc
Express Mail Label No.	EL231019311US

ADDRESS TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [X] * Fee Transmittal Form *(e.g., PTO/SB/17)* *(submit an original and a duplicate for fee processing)*
2. [X] Specification [Total Pages 14] *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) *(35 U.S.C. 113)* [Total Sheets 3] (informals)
4. Oath or Declaration [Total Pages 2] (unsigned)
   a. [ ] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 16 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

5. [ ] Microfiche Computer Program *(Appendix)*
6. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (Identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. [ ] Assignment Papers (cover sheet & document(s))
8. [ ] 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* [ ] Power of Attorney
9. [ ] English Translation Document *(if applicable)*
10. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
11. [ ] Preliminary Amendment
12. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
13. [ ] * Small Entity Statement(s) *(PTO/SB/09-12)* [ ] Statement filed in prior application, Status still proper and desired
14. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
15. [ ] Other: .....

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16. If a **CONTINUING APPLICATION**, *check appropriate box, and supply the requisite information below and in a preliminary amendment:*
[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No: _____/_____
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For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

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METHOD AND SYSTEM FOR EXPORTING FLIGHT DATA FOR LONG TERM STORAGE

BACKGROUND OF THE INVENTION

This invention relates generally to processing aircraft flight data and more particularly to exporting processed flight data for long term storage.

Gas turbine engines used for powering aircraft in flight are routinely subject to various maintenance procedures as part of their normal operation. To aid in the provision of such engine services, aircraft are commonly provided with onboard engine performance monitoring equipment that collects relevant flight data during operation. In some instances, the flight data is collected manually. Airlines commonly use an engine condition monitoring program to analyze the flight data and track the engine's performance. In simple terms, the program monitors the flight data and if a significant change in the flight data is detected, then the program issues an "alert" indicating that maintenance action may be needed.

Generally, such engine condition monitoring programs only retain the last 50-60 data points collected. While the program can be configured to never delete data, the database and program efficiency would quickly become untenable because of the limits of the program's data storage capacity. Thus, most users allow the program to automatically delete the data, retaining only the most recent data points.

However, having an engine's entire life cycle history would be very useful in the overall maintenance of the engine. Being able to evaluate an engine's entire life history would provide valuable additional information on what is normal and abnormal for the engine, as well as providing useful insight into the production and overhaul work practices. Engine condition monitoring programs do have the capability to save past history in the form of compression points. Compression points comprise smoothed values for the first data point of a given time period, such as every month. Unfortunately, these compression points are not very helpful for long term

analyses because they generally do not accurately reflect an engine's performance over a lengthy time period.

Accordingly, it would be desirable to be able to retain all collected flight data without compromising the efficiency of the engine condition monitoring program.

BRIEF SUMMARY OF THE INVENTION

The above-mentioned need is met by the present invention, which provides a method and system for exporting data from the database of an engine condition monitoring program to a destination database. The data export is accomplished by first reading a time file to determine the last date and time that data was successfully exported to the destination database. The program database is then searched for data that is new or changed since the last successful export. Any data found in searching the program database is retrieved and exported to the destination database. After a successful export, the date and time of the successful export is updated in the time file.

The present invention and its advantages over the prior art will become apparent upon reading the following detailed description and the appended claims with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter that is regarded as the invention is particularly pointed out and distinctly claimed in the concluding part of the specification. The invention, however, may be best understood by reference to the following description taken in conjunction with the accompanying drawing figures in which:

Figure 1 is a schematic block diagram of an aircraft flight data handling system including means for exporting flight data to a long term storage database.

Figure 2 is a flow chart illustrating an overall method for extracting and exporting aircraft flight data.

Figure 3 is a detailed flow chart illustrating the extracting and exporting methodology of the method of Figure 2.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings wherein identical reference numerals denote the same elements throughout the various views, Figure 1 shows a block diagram of a flight data handling system 10 for processing flight data collected onboard an aircraft. The system 10 includes a set of conventional data sensors 12 distributed throughout the aircraft to sense selected parameters that are indicative of the overall performance and/or condition of the aircraft and/or its engines. The data sensors 12 can comprise any group of sensors that monitor aircraft and engine parameters of interest. In addition to aircraft parameters such as air speed and altitude, engine parameters would typically include exhaust gas temperature, engine fuel flow, core speed, compressor discharge pressure, turbine exhaust pressure, fan speed, and the like. The flight data sensed by the data sensors 12 are recorded, either manually or electronically, onboard the aircraft in a data recorder 14. As used herein, "data recorder" refers to any type of data recording means and can include electronic recording devices, such as a conventional flight data acquisition unit, as well as written logs into which the flight data are entered by a human operator after being read from cockpit instrumentation.

The flight data recorded in the data recorder 14 are downloaded to a ground-based computer system 16, which can be any type of computer system such as a PC. Manually recorded data would be manually entered into the computer system 16 using standard input means such as a keyboard (not shown). Electronically recorded data could be transferred by any available means, such as a bus connection, wireless transmission or diskette transfer. This data download would typically take place after completion of a flight. Alternatively, electronically recorded data could be

downloaded to the computer system 16 during flight operations using wireless transmission for remote, real-time processing.

The computer system 16 includes an engine condition monitoring program 18 that processes the downloaded flight data. Specifically, the program 18 receives the input data from the aircraft and engine data sensors 12 and calculates raw output data for both the aircraft and engine input data by comparing to parametric baselines. The program 18 also generates smoothed output data from the aircraft and engine raw output data. Any change in the output from previous smoothed levels or levels over a predetermined limit may be indicative of a possible engine condition that requires maintenance. Thus, the program issues an "alert" indicating that maintenance action may be needed.

The program 18 includes a database 20 which stores all of the flight data (i.e., engine input data, engine raw output data, engine smoothed output data, aircraft input data, aircraft raw output data, and aircraft smoothed output data). The program database 20 also stores engine configuration data, aircraft configuration data, alert data, initialization data, and compressed data. These various types of data are stored in different tables within the program database 20. Typically, the program database 20 has a different table for engine input data, engine raw output data, engine smoothed output data, aircraft input data, aircraft raw output data, and aircraft smoothed output data. A process indicator table is provided for identifying the status of each record within each of these tables. That is, the process indicator table contains a status indicator for each record that instructs the program 18 how to operate. For example, records having newly processed data would have a "REPORT" status indicator signifying a need to report the new data, and previously entered records that have been changed or corrected would have a "RE-REPORT" status indicator signifying a need to re-report the altered data.

The program database 20 also has flight data, alert data, initialization data, compression data and configuration data tables. The flight data table contains key information regarding the aircraft's flights, including an aircraft identification

number and data time stamps. The alert data table contains data relating to any alerts that are issued by the program 18. The initialization data table contains aircraft/engine initialization data, which is typically the first ten data points collected. The initialization data table also includes primary key values (i.e., data relating to aircraft identification, flight time, flight phase and so on). The compressed data table contains compression points, which are smoothed values for the first data point of every month, or some other time period. The configuration data tables contain aircraft and engine configuration data.

The computer system 16 further includes an extractor program 22, a destination database 24, and two external files: a time file 26 and a configuration file 28. As is described in detail below, the extractor program 22 extracts from the program database 20 all data that is either new or changed since the last successful export, and exports this extracted data to the destination database 24. The time file 26 is an ASCII file to which the date and time of the last successful execution of the extractor program 22 is written. The configuration file 28 provides data mapping information between the tables in the program and destination databases 20 and 24.

Turning now to Figure 2, a general methodology for extracting and exporting flight data on the program database 20 is described. After the data has been processed by the engine condition monitoring program 18, the extractor program 22 extracts from the program database 20 all data that is either new or changed since the last successful export, as indicated at block 100. The data extracted from the program database 20 includes any desired set of data parameters available on the program database 20. This will typically include engine configuration data, aircraft configuration data, engine input data, engine raw output data, engine smoothed output data, aircraft input data, aircraft raw output data, aircraft smoothed output data, alert data, initialization data, and compressed data.

Next, at block 102, the extracted data is exported to the destination database 24. To do this, the extractor program 22 reads the external configuration file 28 to map the extracted data parameters to their respective table and parameter names

in the destination database 24. The extractor program 22 also has the capability to add some simple parameters to further categorize the data. For example, an alert count for a particular reading can be used in the destination database 24.

At block 104, the extractor program 22 inquires as to whether the extracted data has been successfully exported to the destination database 24. If the export was successful, then the extractor program 22 updates the date and time of the export in the time file 26 for tracking purposes as indicated at block 106. The process is then completed as indicated at block 108. If the export is not successful (for example there is a failure or problem retrieving data from the program database 20 or inserting records into the destination database 24), then the process will be stopped as indicated at block 108. The export date and time in the time file 26 will not be updated; consequently, the extracted data will be re-extracted and exported in a subsequent execution of the process.

Referring to Figure 3, the method for extracting and exporting data from the program database 20 (i.e., the steps identified at blocks 100 and 102 of Figure 2) is described in more detail. The extractor program 22, which performs extraction of the data, is executed manually by the system user or automatically by an execution program. Preferably, the extractor program 22 is run after every flight for which the program 18 is run, but the program 22 can also be executed on a scheduled basis, such as once a week or once a day.

As indicated at block 110 of Figure 3, the extractor program 22 will first read from the external time file 26 the date and time when the last successful execution of the extractor program 22 terminated. If no date and time is found, the extractor program 22 will use a default date and time, which is typically the first date and time that the user began using the engine condition monitoring program 18 in its maintenance operations. The extractor program 22 at block 112 will then read from the external configuration file 28 the table name and column name in the destination database 24 and map or correlate each table and column in the program database 20 to a table and column in the extractor program 22. This will reduce the need to

recompile the extractor program 22 whenever a change is made to either of the program or destination databases 20 or 24.

At block 114, the extractor program 22 will search the flight data table of the program database 20 for flight data that was added or modified after the date and time read from the time file 26. For each flight data record found, the extractor program 22 will retrieve all parameters from the aircraft input, aircraft raw output, and aircraft smoothed output tables, as indicated at block 116. Then for each engine position, the extractor program 22 will also retrieve all parameters from the engine input, engine raw output, and engine smoothed output tables. Finally, the extractor program 22 retrieves all alert data from the alert output table of the program database 20. Also, the status indicator in the process indicator table will be set to "DONE" after each record is processed.

Next, the extractor program 22 will search the process indicator table of the program database 20 for newly processed or reprocessed flight records (i.e., flight records indicated by a status indicator of "REPORT" or "RE-REPORT") as indicated at block 118. For each reprocessed flight record found, the extractor program 22 will retrieve all parameters from the aircraft input, aircraft raw output, and aircraft smoothed output tables, as indicated at block 120. Then for each engine position, the extractor program 22 will also retrieve all parameters from the engine input, engine raw output, and engine smoothed output tables. Finally, the extractor program 22 retrieves all alert data from the alert output table of the program database 20. Also, the status indicator in the process indicator table will be set to "DONE" after each table is processed.

After completing the extraction of flight data, the extractor program 22 searches the initialization data table of the program database 20 at block 122. At block 124, the extractor program 22 retrieves initialization data by finding the primary key values from the initialization data table for which the character value field is equal to "EXTRACT". The character value field is an existing field in the initialization data table that is initially set to "EXTRACT" by the engine condition

monitoring program 18. The extractor program 22 will process each primary key value set and retrieve all the initialization parameter data for that primary key value set. After successful storage of the initialization data in the destination database 24, the character value field will be reset to "NULL" for each affected primary key value set.

Next, at block 126, the extractor program 22 will search the compression data table of the program database 20. At block 128, the extractor program 22 retrieves compression data by finding the primary key values from the compression data table for which the character value field is equal to "EXTRACT". Like the initialization data table, the compression data table contains character value fields that are initially set to "EXTRACT" by the engine condition monitoring program 18 when the primary key values are processed. The extractor program 22 will process each primary key value set and retrieve all the compression parameter data. After successful storage of the compression data in the destination database 24, the character value field will be reset to "NULL" for each affected primary key value set.

The above steps retrieve all data that are new since the date and time read from the time file 26. The searches of the various database tables will also retrieve re-smoothed, re-alerted and backdated data. That is, if a data record that had previously been exported to the destination database 24 is subsequently changed in the program database 20, then the extractor program 22 will update this data record in the destination database 24. Also the extractor program 22 automatically updates the destination database 24 in the case of a backdated engine install. For example, if an engine on the aircraft is changed, data entered prior to removal date of the previous engine will apply to that engine and will need to be extracted from the destination database 24. Data associated with the old engine but collected after the removal date is also deleted from the destination database 24.

As each flight data record is retrieved at block 116, each reprocessed flight record is retrieved at block 120, each initialization data record is retrieved at

block 124, and each compression data record is retrieved at block 128, the parameter data will be re-formatted as needed for the destination database 24 as indicated at block 130. Then, at block 132, all of the reformatted data is output to the destination database 24, thereby completing the extraction and export process. If there are any problems inserting the reformatted data into the destination database 24, then extractor program 22 will search the configuration tables of the program database 20 for aircraft and engine configuration data that is new or changed since the date and time read from the time file 26. Such configuration data will be retrieved and exported to the destination database 24. If there is still a problem exporting any of the data, then the process will be stopped as discussed above at blocks 104 and 108 of Figure 2. If all data is successfully extracted and exported to the destination database 24, the extractor program 22 will write the date and time the processing has terminated to the external time file 26 as discussed above at block 106 of Figure 2.

The foregoing has described a method and system of exporting data from an engine condition monitoring program to long term storage. While specific embodiments of the present invention have been described, it will be apparent to those skilled in the art that various modifications thereto can be made without departing from the spirit and scope of the invention as defined in the appended claims.

WHAT IS CLAIMED IS:

1. A method of exporting data from an engine condition monitoring program database to a destination database, said method comprising:

extracting data from said program database;

exporting said extracted data to said destination database; and

after a successful export, updating an external time file with the date and time of said successful export.

2. The method of claim 1 wherein said step of extracting data from said program database comprises extracting only data that is new or changed since the previous successful export.

3. The method of claim 1 wherein said step of extracting data from said program database comprises extracting data from the group comprising engine configuration data, aircraft configuration data, engine input data, engine raw output data, engine smoothed output data, aircraft input data, aircraft raw output data, aircraft smoothed output data, alert data, initialization data and compressed data.

4. The method of claim 1 further comprising mapping tables and columns in said program database to tables and columns in said destination database.

5. In a computer system running an engine condition monitoring program having a program database comprising a number of data tables, a method of exporting data from said program database to a destination database, said method comprising:

reading an external time file to determine the last date and time that data was successfully exported to said destination database;

searching said program database for data that is new or changed since said last successful export;

retrieving data found in searching said program database;

exporting said retrieved data to said destination database; and

after a successful export, updating said external time file with the date and time of said successful export.

6. The method of claim 5 wherein said step of retrieving data from said program database comprises retrieving data from the group comprising engine configuration data, aircraft configuration data, engine input data, engine raw output data, engine smoothed output data, aircraft input data, aircraft raw output data, aircraft smoothed output data, alert data, initialization data and compressed data.

7. The method of claim 5 further comprising mapping tables and columns in said program database to tables and columns in said destination database.

8. The method of claim 5 wherein said program database includes a flight data table, and a number of engine data tables and aircraft data tables and said step of searching said program database comprises searching said flight data table for flight data that is new or modified since said last successful export.

9. The method of claim 8 wherein said step of retrieving data comprises retrieving data from said engine data tables and said flight data tables for each flight data record found in said flight data table.

10. The method of claim 9 further comprising providing each of said engine data tables and said aircraft engine tables with an indication that data retrieval is completed after said flight data is retrieved from each table.

11. The method of claim 5 wherein said program database includes a process indicator table, and a number of engine data tables and aircraft data tables and said step of searching said program database comprises searching said process indicator table for reprocessed flight data that is changed since said last successful export.

12. The method of claim 11 wherein said step of retrieving data comprises retrieving data from said engine data tables and said aircraft data tables for each reprocessed flight data record found in said process indicator table.

13. The method of claim 12 further comprising providing each of said engine data tables and said aircraft engine tables with an indication that data retrieval is completed after said reprocessed flight data is retrieved from each table.

14. The method of claim 5 wherein said program database includes an initialization data table, and said step of searching said program database comprises searching said initialization data table for initialization data that is changed since said last successful export.

15. The method of claim 14 wherein said step of retrieving data comprises retrieving initialization data found in said initialization data table.

16. The method of claim 15 further comprising providing said initialization data table with an indication that data retrieval is completed after said initialization data is retrieved from said initialization table.

17. The method of claim 5 wherein said program database includes a compression data table, and said step of searching said program database comprises searching said compression data table for compression data that is changed since said last successful export.

18. The method of claim 17 wherein said step of retrieving data comprises retrieving compression data found in said compression data table.

19. The method of claim 18 further comprising providing said compression data table with an indication that data retrieval is completed after said compression data is retrieved from said compression table.

20. A computer system comprising:

an engine condition monitoring program having a program database;

a destination database;

a time file;

means for extracting data from said program database;

means for exporting said extracted data to said destination database; and

means for updating said external time file with the date and time of a successful export.

21. The computer system of claim 20 further comprising a configuration file containing information for mapping tables and columns in said program database to tables and columns in said destination database.

METHOD AND SYSTEM FOR EXPORTING FLIGHT DATA FOR LONG TERM STORAGE

ABSTRACT OF THE DISCLOSURE

The availability of flight data used in the maintenance of aircraft engines is enhanced by exporting data from the database of an engine condition monitoring program to a long term database. The data export is accomplished by first reading a time file to determine the last date and time that data was successfully exported to the destination database. The program database is then searched for data that is new or changed since the last successful export. Any data found in searching the program database is retrieved and exported to the destination database. After a successful export, the date and time of the successful export is updated in the time file.

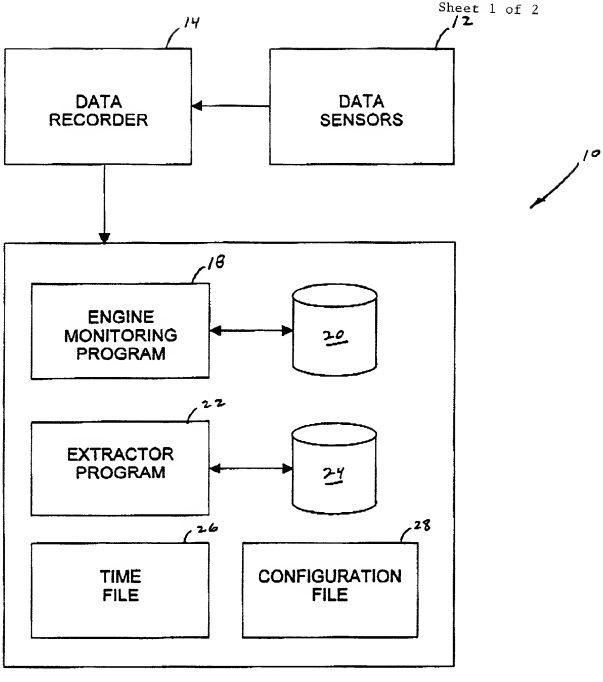
14
12
DATA RECORDER
DATA SENSORS
10
18
ENGINE MONITORING PROGRAM
20
22
EXTRACTOR PROGRAM
24
26
TIME FILE
28
CONFIGURATION FILE

FIG. 1

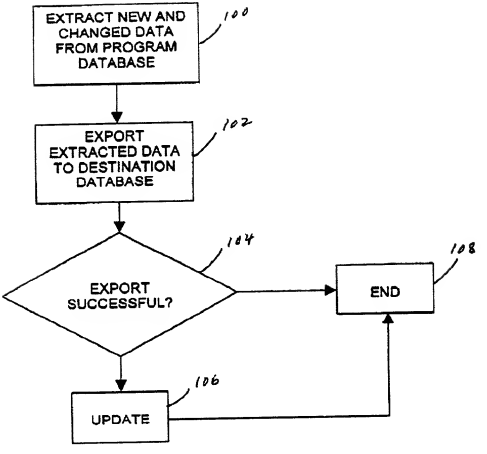
EXTRACT NEW AND CHANGED DATA FROM PROGRAM DATABASE
100
EXPORT EXTRACTED DATA TO DESTINATION DATABASE
102
EXPORT SUCCESSFUL?
104
END
108
UPDATE
106

FIG.2

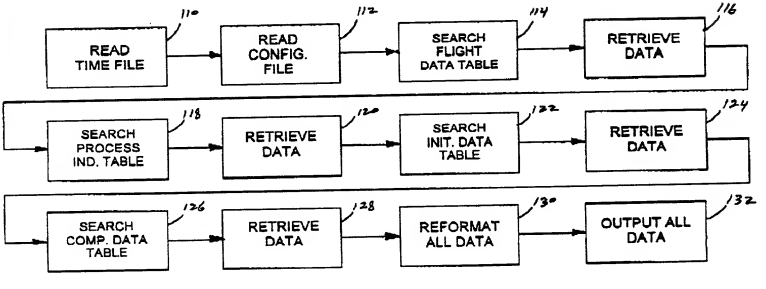
READ TIME FILE
110
READ CONFIG. FILE
112
SEARCH FLIGHT DATA TABLE
114
RETRIEVE DATA
116
SEARCH PROCESS IND. TABLE
118
RETRIEVE DATA
120
SEARCH INIT. DATA TABLE
122
RETRIEVE DATA
124
SEARCH COMP. DATA TABLE
126
RETRIEVE DATA
128
REFORMAT ALL DATA
130
OUTPUT ALL DATA
132

FIG. 3

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

Docket Number
13DV13511

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

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METHOD AND SYSTEM FOR EXPORTING FLIGHT DATA FOR LONG TERM STORAGE

the specification of which

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I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

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I hereby claim foreign priority benefits under Title 35, United States Code §119 (a)-(d) or §365 (b) of any foreign application(s) for patent or inventor's certificate, or §365 (a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

PRIOR FOREIGN APPLICATION(s) **Priority Claimed**

(Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed
			☐ Yes ☐ No
			☐ Yes ☐ No

☐ Additional foreign application numbers are listed on a supplemental priority data sheet attached hereto.

I hereby claim the benefit under Title 35, United States Code §119 (e) of any United States provisional application(s) listed below.

(Application Number)	(Filing Date)

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I hereby claim the benefit under Title 35, United States Code §120 of any United States Application(s), or §365 (c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

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United States Patent & Trademark Office

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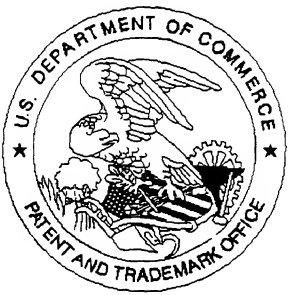

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☐ Page(s)_____ of _____ were not present for scanning. (Document title)

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